ARI Research Note 92-01

Causal Schema Decision-Aiding System

Gerald Hopple
Defense Systems, Inc.

Field Unit at Fort Leavenworth, Kansas
Stanley M. Halpin, Chief

Systems Research Laboratory
Robin L. Keesee, Director

October 1991

United States Army
Research Institute for the Behavioral and Social Sciences

U.S. ARMY RESEARCH INSTITUTE FOR THE BEHAVIORAL AND SOCIAL SCIENCES

A Field Operating Agency Under the Jurisdiction of the Deputy Chief of Staff for Personnel

EDGAR M. JOHNSON
Technical Director

MICHAEL D. SHALER
COL, AR
Commanding

Research accomplished under contract
for the Department of the Army

Defense Systems, Inc.

Technical review by

Rex Ronald Michel

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS --
2a. SECURITY CLASSIFICATION AUTHORITY --	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE --	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) --	5. MONITORING ORGANIZATION REPORT NUMBER(S) ARI Research Note 92-01
6a. NAME OF PERFORMING ORGANIZATION Defense Systems, Inc. 6b. OFFICE SYMBOL (If applicable) --	7a. NAME OF MONITORING ORGANIZATION U.S. Army Research Institute
6c. ADDRESS (City, State, and ZIP Code) 7903 Westpark Drive McLean, VA 22333-5600	7b. ADDRESS (City, State, and ZIP Code) Fort Leavenworth Field Unit P.O. Box 3407 (PERI-SL) Fort Leavenworth, KS 66027-0347
8a. NAME OF FUNDING/SPONSORING ORGANIZATION U.S. Army Research Institute for the Behavioral and Social Sciences 8b. OFFICE SYMBOL (If applicable) PERI-S	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER MDA903-85-C-0191
8c. ADDRESS (City, State, and ZIP Code) 5001 Eisenhower Avenue Alexandria, VA 22333-5600	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. 62717A; PROJECT NO. 790; TASK NO. 145; WORK UNIT ACCESSION NO. N/A
11. TITLE (Include Security Classification) Causal Schema Decision-Aiding System	
12. PERSONAL AUTHOR(S) Hopple, Gerald	
13a. TYPE OF REPORT Final	13b. TIME COVERED FROM 85/04 TO 85/10
14. DATE OF REPORT (Year, Month, Day) 1991, October	15. PAGE COUNT 49
16. SUPPLEMENTARY NOTATION Contracting Officer's Representative, Stanley M. Halpin	

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Command and control Causal schema Tactical planning

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This report looks at the use of causal schema to organize concepts for understanding complex decision processes. The task selected for developing a prototype causal schema decision-aiding system was to implement portions of a fire support annex for a Corps operations order. A series of storyboards was developed based on an analysis of the prescribed elements of the Annex; the storyboards were evaluated as a prototype "decision aid." The author concludes that causal schema is useful in describing tactical decision processes and may offer advantages over rule-based approaches (e.g., artificial intelligence) in developing decision aids.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL Stanley M. Halpin	22b. TELEPHONE (Include Area Code) (913) 684-4933 22c. OFFICE SYMBOL PERI-SL

DD Form 1473, JUN 86 *Previous editions are obsolete.* SECURITY CLASSIFICATION OF THIS PAGE
UNCLASSIFIED

CAUSAL SCHEMA DECISION-AIDING SYSTEM

CONTENTS

LIST OF FIGURES

CAUSAL SCHEMA DECISION-AIDING SYSTEM

BACKGROUND

Command and control in ground combat has always involved difficult decision-making tasks. Historically these difficulties have been exacerbated by the fact that commanders (and their staffs) have had to deal with uncertain information, delays in receiving reports and in transmitting directives, as well as the complexities associated with employing diverse units in accordance with their individual and collective capabilities and vulnerabilities. While warfare has continued to evolve over time, and especially since the end of the Second World War, these difficulties persist and may have increased.

- Information remains uncertain. While the quality of sensor-derived information has improved significantly, increased numbers of sensors and advances in communications have magnified the volume of information available to individual commanders--far outstripping existing processing capabilities.
- Communications systems have improved and delays have been reduced, but modern jamming, other countermeasures, and reliability problems can still delay or even prevent the passage of information.
- The complexity of optimizing force capabilities and vulnerabilities has grown significantly with the proliferation of new systems. Further, effective use of these advanced systems demands detailed technical information.
- With the increase in the pace of battle and the tremendous firepower now available to commanders, mistakes can be more costly and have greater impact on a force's situation.

In recent years computers (and particularly microcomputers) have been used to support the decisionmaking process. Originally this support was centered around simple functional tasks such as spread sheets and computational routines which produced periodic reports and presented them in a form that allowed commanders and staffs to see trends, make comparisons, and develop insights. This support has also involved highly structured, rule-based applications such as the allocation of nuclear weapons to a set of targets.

With the development of artificial intelligence capabilities, decision aiding systems based on sets of logical rules have been developed in a number of areas where repetitive patterns occur. These have been most successful in such fields as diagnosing diseases, decisions concerning locations of potential oil drilling sites, and identification of maintenance and repair problems. Expert or knowledge based system will be operational in the 1990's in a number of C^3I problem-solving contexts that are well bounded and characterized by extensive formal understanding (Andriole and Hopple, 1985). However, such systems have proven to be of relatively little value in supporting creative decision processes such as military planning that are less well understood and not as susceptible to formal deterministic or probabilistic analysis. A new approach called "causal schema" has emerged and shows promise in the laboratory for assisting people involved in creative tasks where no algorithms or clear cut rules exist.

CAUSAL SCHEMA

The central role of causal assessment in human thinking and decisonmaking is clearly reflected in the standard AI knowledge representation schemes (Barr and Feigenbaum, 1981; Hayes-Roth, et al, 1983). The causal schema approach assists decisionmaking by leading the user through a logical process. It assumes that creative processes can be stimulated by a combination of creating an understanding of what is to be accomplished, suggesting some ways that it can be thought about, asking questions (both rhetorical questions as reminders of key elements, and real questions as a way of stimulating useful responses), and recording responses in a structured way.

People in general--including military decisionmakers--do not generally perform well as intuitive scientists. They have few or no qualms about immediately (and, in fact, apparently spontaneously) attributing an observed effect to one or more causes. Often however, the principle of "misguided parsimony" holds, with an overreliance on simplistic models of causation (including the frequent failure to go beyond a single, salient probable cause). Causal inference does not always occur in an unbiased fashion. Furthermore, there is rarely a self-evident or simple "right" answer to the question of what causes something (Hopple, 1984; Nisbett and Ross, 1980).

Aids which support decision making should be genuinely interactive and dynamic systems rather than expert systems which mimic (and could potentially replace) the problem-solver. They should be capable of generating the commander's (or staff member's) generic causal structure or schema, interacting with the user to embellish his cognitive

map of the problem domain, and offering "advice" about how to expand or refine the schema. The generic schema would be created, refined, stored, and updated or revised as necessary. Depending on changing causal parameters and constraints, the dynamic form of the schema would be capable of varying its contents and even its structure. The causal schema-based decision aiding system would thus genuinely marry the expert and the expert system, creating an active knowledge-based system midway between a "naked expert" and a passive, automated expert system. The aid would also constitute an adaptive decision support system. In addition to being adaptive and interactive, future versions of the aid could be designed as self-learning systems, systems capable of making significant changes in their internal processing logic in response to user demands or on the basis of demands placed on the system in the past. A dynamic, changing battlefield and the need to counter deception and communications interference require this kind of decision aiding system.

OBJECTIVES

Three technical objectives were established for this project:

- Develop a prototype causal schema decision aiding system for use in the tactical environment.
- Evaluate the performance of the prototype.
- Conduct a preliminary assessment of the value of the causal schema approach for other problem domains in tactical planning and decision making.

CAUSAL SCHEMA FIRE SUPPORT PLANNER

Introduction

In determining which specific planning process was to be used as the basis for the causal schema decision aiding system, the following needs were considered:

- The selected process had to fit within realistic and recognizable boundaries.
- The problems chosen had to involve creative planning (not rule-based or algorithmic) processes.
- The decision aiding system needed to be compatible with an existing scenario for which quality planning could be recognized.

Based on these considerations, a Fire Support Annex supporting a Corps Operations Plan was determined to be an appropriate vehicle for the development of the prototype causal schema decision aiding system. Since the scope of this program was limited (in terms of both period of performance and level of effort), only portions of the Fire Support Annex were selected to be implemented in the prototype. The format for the Fire Support Annex is provided as Figure 1; those portions implemented in the prototype are identified.

The LETORT scenario (and its supporting Corps Operations Plan) was selected to form the background for the development of the Fire Support Annex. This scenario, which supports the Army War College Theater and Corps Operations and Planning Simulation (TACOPS), depicts an initial unprovoked attack by Soviet forces in the southern portion of what is

X 1. SITUATION

A. Enemy Forces
B. Friendly Forces
C. Attachments and Detachments

X 2. MISSION

3. EXECUTION

X A. Concept of Operation
X B. Air Support
(1) General
(2) Allocation
(3) Miscellaneous
C. Chemical Support
(1) General
(2) Prescribed Chemical Load
(3) Miscellaneous
X D. Field Artillery Support
(1) General
(2) Organization for Combat
(3) Miscellaneous
E. Naval Gunfire Support
(1) General
(2) Organization
(3) Miscellaneous
F. Nuclear Fire Support
(1) General
(2) Prescribed Nuclear Load
(3) Miscellaneous
X G. Coordinating Instructions

4. SERVICE SUPPORT

5. COMMAND AND SIGNAL

A. Command
B. Signal

The prototype decision aiding system addresses only portions of the Fire Support Annex; those portions addressed are indicated with an X.

Figure 1. Fire Support Annex Format

commonly referred to as the North German Plain. In this scenario the 11th Corps has been assigned to a newly formed Middle Army Group (MIDAG).

Overview of the Prototype Fire Support Planner

Figure 2 illustrates the overall causal schema. The arrows represent both the planning logic and causal flows in fire support planning. For example, the physical environment impacts the commander's concept and also sets the initial parameters for the fire support concept. The latter is also influenced by the mission, fire support assets available, and the evolving commander's concept. Battlefield situation scenarios also have a major influence over the fire support concept. These scenarios represent the mental (and sometimes verbal) wargaming of each probable enemy course of action to visualize how the battle might progress given the range of potential friendly responses.

As indicated in Figure 2, six factors impact the fire support concept and through it, the Fire Support Annex:

- The mission, the commander's concept and those of the next senior headquarters.
- The physical environment which addresses the characteristics of the terrain, and the impact of the terrain on enemy/friendly courses of action.
- Dealing with enemy forces, which leads to six basic data questions that are important:
  - What forces oppose you?
  - Where are the enemy forces?
  - What is the enemy's probable course of action?
  - What is the enemy's timetable?

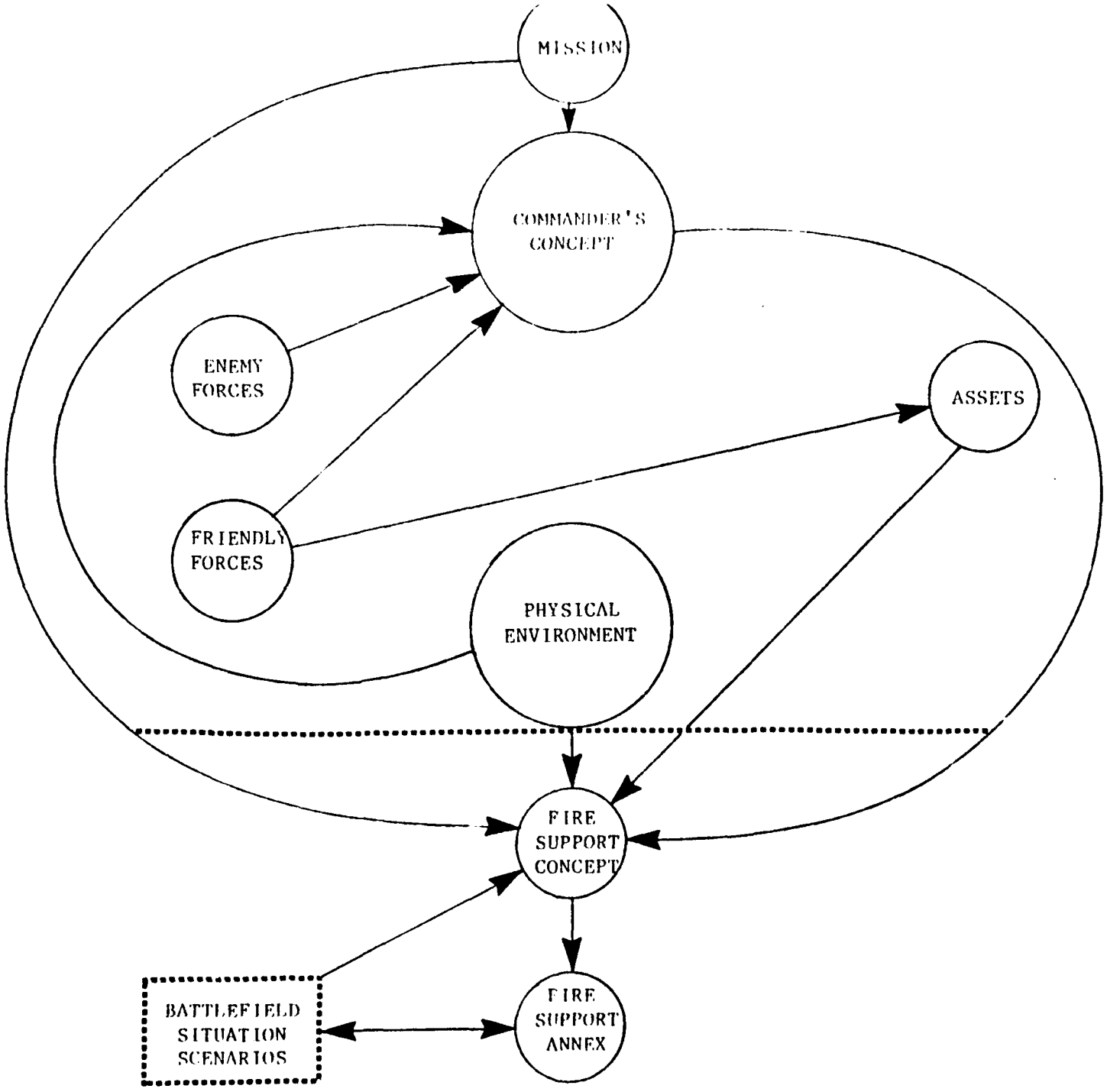


Figure 2. Overall Fire Support Planning Causal Schema

- Where are the enemy's reserves?

- What other courses of action could the enemy employ?

- The Fire Support Annex which must be coordinated with the fire support plans of friendly forces (both higher and adjacent headquarters).

- Assets, which address friendly fire support elements currently available and those which will become available in time to support the commander's concept.

As indicated in Figure 3, the Fire Support Annex is developed from the fire support concept using four basic planning tasks:

- Identifying fire support needs over space and time: Where, how much, in what sequence, and at what time would fires most likely be required to support the covering force, the main battle, the deep battle, and rear area combat operations, considering enemy and own probable/alternate courses of action.

- Determining if available assets cover the identified needs: What fire support assets are required to support the identified needs; what assets are available; if additional assets are required, can they be obtained.

- Linking available assets to the identified needs: Which asset (or set of assets) is most likely to be required to support each need (or set of needs) for the covering force, the main battle, the deep battle, and rear area combat operations.

- Positioning available assets over space and time: What allocation of close air support and field artillery organization for combat is most appropriate to support the covering force, the main battle, the deep battle, and rear area combat operations; what coordinating instructions are appropriate.

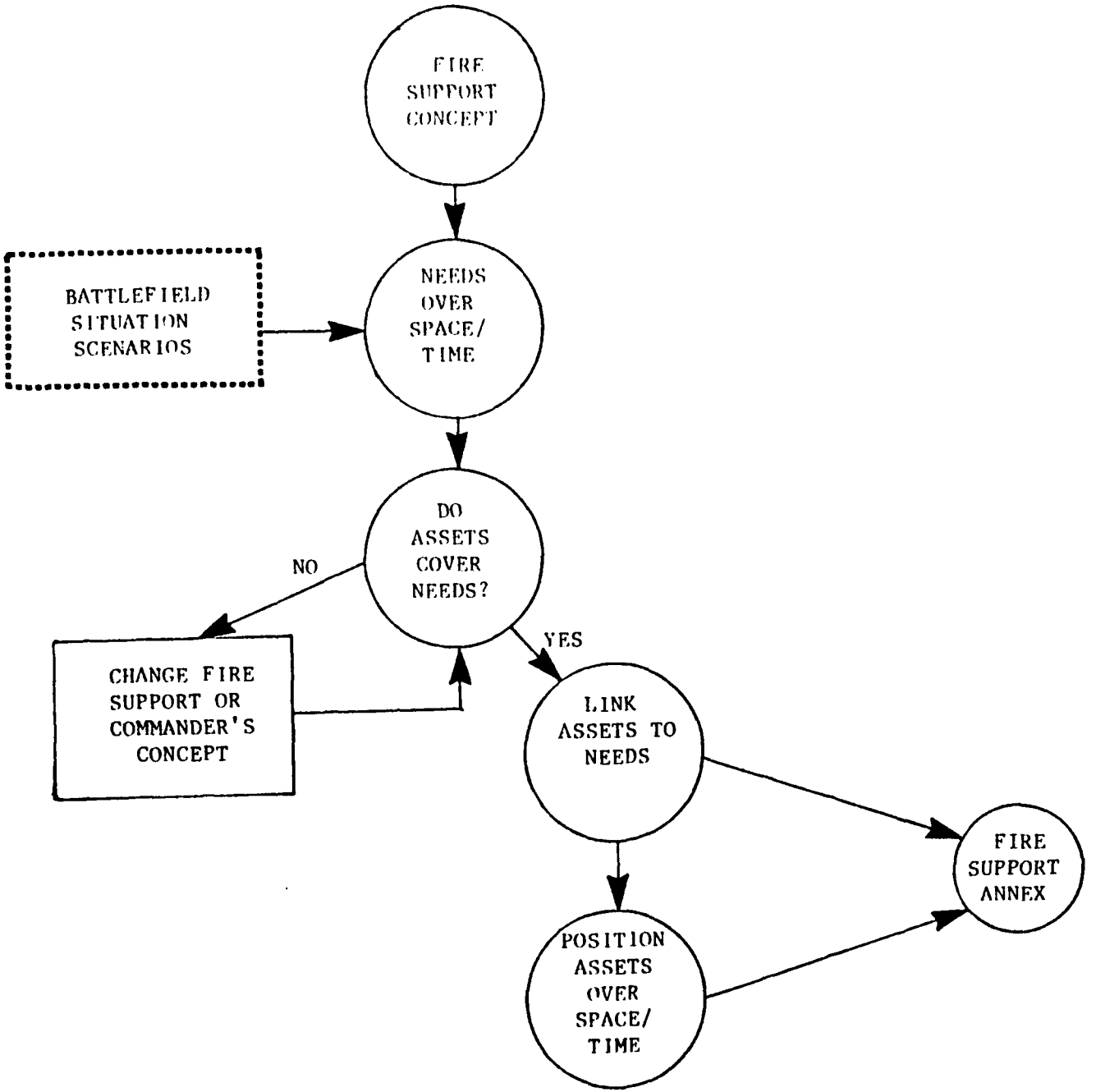


Figure 3. Causal Schema Fire Support Planning Process

Prototype Fire Support Planner

The prototype fire support planner, which is included as Appendix I, consists of a series of storyboards (i.e., representations of computer screens) which provide the basic structure of the aid. What are not included are the support instructions which assist the operator in moving from screen to screen, either forward or reverse, or the word processing functions which provide the completed plan.

The prototype uses a questioning technique with three types of questions:

- Questions which do not require a written response, but merely serve as guides to the planning process. As illustrated below, these do not provide space for a response. However, should the operator wish to insert a response/comment, he is free to do so; any such responses/comments will be retained in the particular storyboard and will be included any time a particular screen is subsequently requested by the operator.

  Where are the enemy forces?

- Questions which require a written response which will be used later in the planning process. These provide space for a response immediately after the question, as illustrated below:

  What is the enemy's probable course of action? _____

- Questions which require a written response which are directly inserted into the completed Fire Support Annex. These provide space for a formatted response (i.e., paragraphed to correspond to the Fire Support Annex format), as illustrated below:

What is the required fire support task (i.e., mission)?

2. MISSION

As an aid to the user, preceding each set of questions is a graphic illustrating the planning process to be addressed.

EVALUATION AND VALIDATION

Introduction

As originally proposed, the evaluation and validation of the causal schema decision aiding system was to have consisted of two phases:

- Evaluation of the prototype fire support planner by six to ten mid-level (Captains and Majors) Field Artillery Officers at Fort Sill and Fort Leavenworth using a formal before and after research design with control for order.
- Evaluation of the prototype fire support planner by four senior (Lieutenant Colonels and Colonels) Field Artillery Officers at the Army War College using the same before and after design.

Unfortunately, necessary personnel could not be made available at either Fort Sill or Fort Leavenworth, and those which could be made available at the Army War College, could not be made available for a sufficient period of time to permit a valid test using the most desireable technique. As a result revised evaluation procedures were developed.

Procedures

The evaluation of the prototype fire support planner was conducted using an overall approach very similar to the Continuous and Comprehensive Evaluation (C^2E) concept recently adopted by the Army in which systems (and particularly command and control systems) are evaluated throughout their development process, rather than the more structured conventional testing called for in AR 71-3. In this concept, which could be described as build-a-little, test-a-little, and build-a-little-more, the results of each evaluation directly impacts subsequent development processes.

In applying the C^2E concept to the prototype fire support planner, personnel from the ARI Field Unit at Fort Leavenworth and the Army War College articipated in a five step process.

- *Evaluation by ARI personnel:* The initial causal schema for fire support planning was reviewed by the following personnel of the ARI Field Unit at Fort Leavenworth:
  - Dr. S. M. Halpin, Chief
  - Major J. Flanagan, R&D Cordinator
- Development of the initial prototype fire support planner: The comments and suggested changes developed as a result of the evalution by Dr. Halpin and Major Flanagan were incorporated into causal schema used for the fire support planner.
- Evaluation by senior faculty members of the Army War College: The initial prototype fire support planner was evaluated by the following personnel at the Army War College (this evaluation included a detailed step-by-step walkthrough of each of the initial storyboards):
  - Colonel J. P. Stewart, Director of the Center for Land Warfare

- Mr. J. E. Struve, Technical Advisor for the Center for Land Warfare

- As indicated earlier, the LETORT Scenario (which depicts an unprovoked attack by Soviet forces in Central Europe) was used as the basis for developing the prototype fire support planner. In order to ensure that evaluators were exposed to sufficient background material, a pre-evaluation package was provided each evaluator several days prior to each evaluation. This package included:

  - A brief introduction to causal schema decision aiding systems

  - An introduction to the scenario

  - A hypothetical set of notes from the Corps Commander's staff meeting. These notes included: mission; analysis of weather and terrain; likely enemy courses of action; operations order of the corps' higher headquarters; and red order of battle.

- Development of the prototype fire support planner: The comments and suggested changes developed as a result of the evaluation by Colonel Stewart and Mr. Struve were incorporated into the initial prototype fire support planner used for the final evaluation.

- Evaluation by Army War college faculty and students: The prototype fire support planner was evaluated by the following personnel using the same procedures employed in the previous evaluation of the initial prototype by Colonel Stewart and Mr. Struve.

  - Colonel W. O. Staudenmaier, Land Warfare Studies, Center For Land Warfare

  - Lieutenant Colonel R. W. Zawilski, incoming Director Corps/Army Studies, Center For Land Warfare

  - A Lieutentant Colonel (P) student at the Army War College with extensive field artillery experience at battalion, brigade, and corps level

- A Lieutenant Colonel (P) student at the Army War College with field artillery experience at battalion, brigade, and division level and at the Field Artillery Center and School

The comments and suggested changes developed as a result of final evaluation are not reflected in the prototype fire support planner included as Appendix I.

Findings

The evaluation findings have been segmented into three categories: specific lessons learned on the prototype fire support planner; manner of presentation of causal schema decision aiding systems; and utility of causal schemas in military decision aiding systems.

- Prototype fire support planner lessons learned
  - The graphics illustrating the planning processes should be available to introduce the decision aiding system and to enhance training, but should not be automatically presented each time the system is used.
  - In addition to the information provided on friendly fire support assets (FRIENDLY FORCES/ASSETS Storyboard), information on the status of each asset, its current position and tactical mission, and its ability to move should be provided.
  - Available information on air support assets (FRIENDLY FORCES/ASSETS) is insufficient. There is a need to identify numbers of preplanned sorties and the number of sorties available for quick response.
  - The fire support concept of operation (MISSION/CONCEPT OF OPERATION) should be relabeled as the "initial" concept of operation, recognizing that it might change as as result of the planning process. Provision

should be made to incorporate a review/ rewrite of the concept of operation during ASSETS AVAILABLE/NEEDS.

- In identifying where fires most likely would be required (NEEDS OVER SPACE), the type of ammunition which would be required should also be projected.

- The identifier "R" is used to signify two different situations (NEEDS OVER SPACE).

- There is a need to incorporate a more formal Target Value Analysis (a rule-based process) instead of the Target Threat Analysis (LINK ASSETS TO NEEDS).

- In developing the field artillery organization for combat (POSITION ASSETS OVER SPACE/TIME), additional emphasis should be placed on the likelihood of "on order" missions.

- Coordinating Instructions (POSITION ASSETS OVER SPACE/TIME) should be fleshed out; local standing operating procedures should be built into the planner

• Causal schema manner of presentation

- The ability to build a map, or add and suppress overlays to a map, would increase the effectiveness of a decision aiding system significantly. (One evaluator went so far as to state that the ability to use, or not use overlays which depict boundries, locate friendly/enemy fire support assets, provide range "fan" for friendly/enemy fire support assets, etc. could reduce the corps-level planning process by hours.)

- There is a need to differentiate what information is displayed (and how it is displayed) based on who is supposed to use the decision aiding system. For example the technician/ junior staff officer would require all the detail incorporated in the prototype fire

support planner which supports the development of anticipated requirements for supporting fires, whereas the decisionmaker/ senior staff officer would only be required to view and confirm or modify the resultant recommendations.

- Since causal schema decision aiding systems would be used in conjunction with other systems (i.e., algorithmic/rule-based decision aids, manual systems) which would normally be off-line, there is a requirement that they have the capability to operate with a "finger in the book" mode, wherein the operator could leave, perform an off-line function, and return to pick up exactly where he left off without any loss of data.

- There is a need to have as much information as possible prestored or provided by technical personnel in advance, so the decisionmakers/senior staff officers can focus on the planning/decisionmaking process.

- Utility of causal schemas in military decision aiding systems

  - Knowledge-based causal schema decision aiding systems are superior to algorithmic/rule based systems for creative processes in unbounded problems similar to military tactical planning.

  - Knowledge-based causal schema decision aiding systems could be very valuable as training vehicles.

  - Knowlege-based causal schema decision aiding systems should be employed with algorithmic/ rule based systems and kinematic displays to expand their overall utility.

CONCLUSIONS

The prototype fire support planner demonstrated that a causal schema knowledge-based decision aiding system can be developed for use in the tactical planning environment and can be used as a basis for a knowlege-based system designed for specific battlefield operations.

However, although development of a causal schema decision aiding system for development of Fire Support Annex was useful, it is apparent that to take full advantage of the causal schema methodology requires application at the tactical planning level. In this application, the causal schema decision aiding system would act as a front-end processor (i.e. an intelligent front end) by orchestrating the use of the lower level management information systems and rule-based and algorithmic decision aids.

As a front-end processor the decision aiding system would use information generated by other aids to manage the command and control planning process. It would use a "finger in the book" scheme where one could leave the planning process, query one of the other systems (i.e. for effective weapon range, opponent's likely course of action, available units and etc.), and return without loss of data.

The design of a decision aiding system for the planning process would, naturally, require a more flexible schema than that designed specifically for Fire Support. It would need to be based on the overall decisionmaking process and concern itself more with generalized command and control than with specific applications.

RECOMMENDATIONS

DSI has developed, under contract to DCA, a paradigm for modeling the command and control process. This model views the process as that of six sequential steps: monitor the environment, understand, generate options, predict the outcomes of each option, select an option, direct forces. The model led to development of the Headquarters Effectiveness Assessment Tool (HEAT) which permits the evaluation of the staff process by providing MOEs for overall effectiveness and efficiency of the individual processes.

It is recommended that a decision aiding system be developed (in a Phase II SBIR Program) that uses the causal schema methodology within the context of the HEAT framework for use as a front-end processor to support tactical planning. This approach has the benefit of using an accepted paradigm that has been tested in several single service and joint service exercises and that has a proven evaluation methodology. It would, of course, be necessary to tailor the process measures of the generic HEAT model for this application, however the overall effectiveness measure of whether or not better plans are created is directly applicable.

REFERENCES

Andriole, S. J. & Hopple, G. W. (1985). Sourcebook of Artificial Intelligence. Princeton, NJ: Petrocelli Books.

Barr, A. & Feigenbaum, E. A. (1981). The Handbook of Artificial Intelligence. Vol. I. Los Alto, CA: William Kaufman.

Hayes-Roth, F., Waterman, D. A. & Lenat, D. B. (1983). Building Expert Systems. Reading, MA: Addison-Wesley.

Hopple, G. W. (1984). Prophets and profits: Expert-based corporate crisis forecasting systems. In S. J. Andriole (Ed.) Corporate Crisis Management. Princeton, NJ: Petrocelli Books (pp. 123-146).

Nisbett, R. E. & Ross, L. (1980). Human Inference: Strategies and Shortcomings of Social Judgment. Englewood Cliffs, NJ: Prentice-Hall.

APPENDIX A

PROTOTYPE FIRE SUPPORT PLANNER

FIRE SUPPORT PLANNER

DEVELOPED FOR:

DEPARTMENT OF THE ARMY
U.S. ARMY RESEARCH INSTITUTE FOR THE
BEHAVIORAL AND SOCIAL SCIENCES
FORT LEAVENWORTH FIELD UNIT
LEAVENWORTH, KANSAS

DEVELOPED BY:

DEFENSE SYSTEMS, INC.
McLEAN, VIRGINIA

OVERVIEW

This prototype planning aid consists of a series of storyboards (i.e., representations of computer screens) which provide the basic structure of the aid. What are not included are the supporting instructions which assist the user in moving from screen to screen, either forward or reverse, or the word processing functions which provide the completed Fire Support Annex.

This aid uses a questioning technique with three types of questions:

- Questions which do not require a written response, but merely serve as guides to your planning process. These do not provide space for a response. However, should you wish to insert a response/comment, you are free to do so; any such response/comment will be retained in the particular storyboard and will be included any time that screen is subsequently requested.

- Questions which require a written response which will be used later in the planning process. These provide space for a response immediately after the question, as illustrated below:

  What is the enemy's probable course of action? _____

- Questions which require a written response which will be directly inserted into the completed Fire Support Annex. These provide space for a formatted response (i.e., paragraphed to correspond to the Fire Support Annex format), as illustrated below:

  What is the required fire support task (i.e., mission)

  2. MISSION

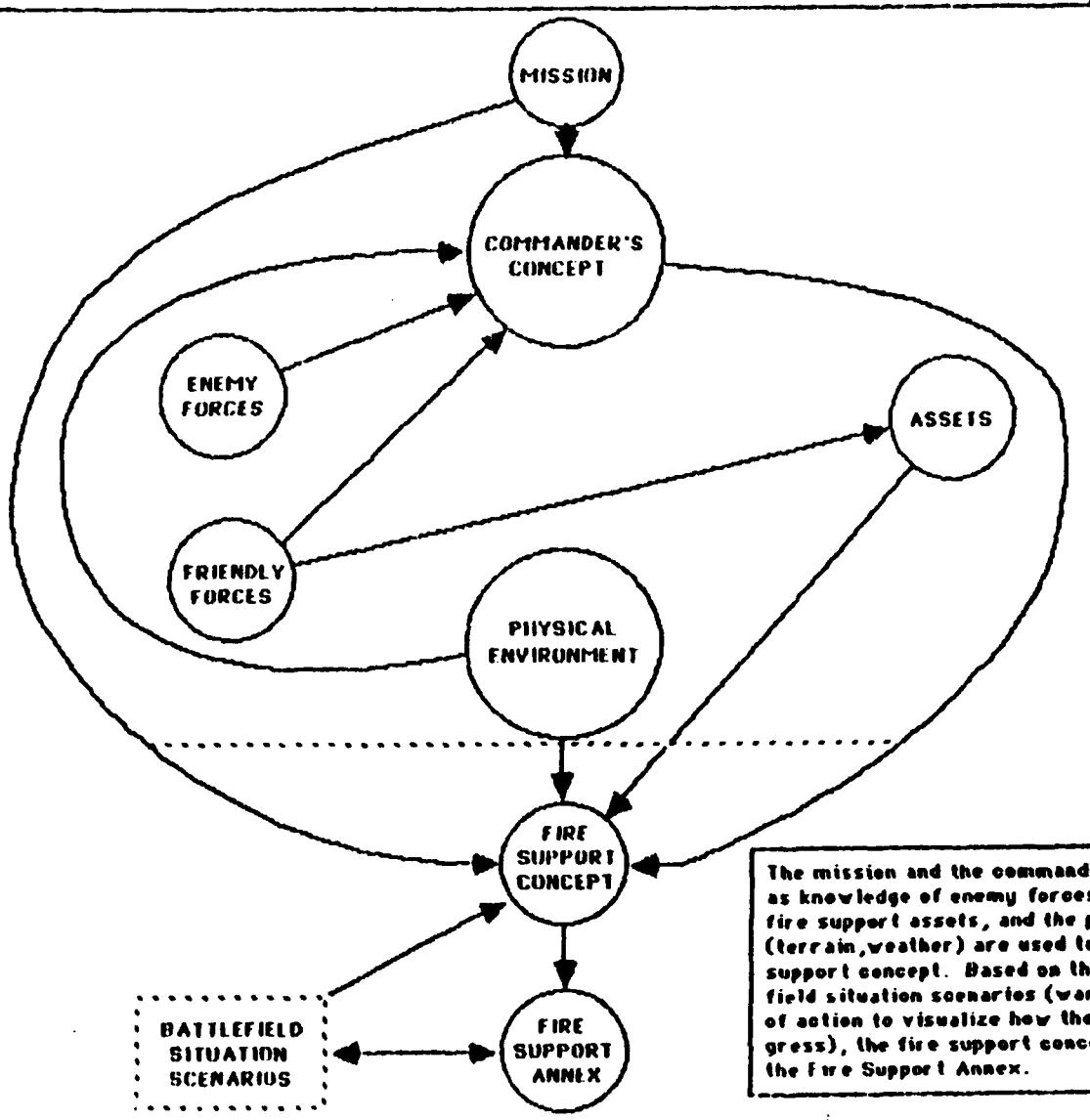
  _____

OVERVIEW

As an aid to the user, preceding each set of questions is a graphic illustrating the planning process to be addressed.

Note: This prototype aids the development of major portions of a Fire Support Annex to an Operation Plan supporting a Corps in Defense of Western Europe. Since this prototype is designed to test the causal-schema concept, only selected portions of the Fire Support Annex are addressed. Those portions not addresed include: Chemical Support, Naval Gunfire Support, Nuclear Fire Support, Service Support, and Command and Signal.

OVERALL FIRE SUPPORT PLANNING CAUSAL SCHEMA



The mission and the commander's concept, as well as knowledge of enemy forces, friendly forces/ fire support assets, and the physical environment (terrain,weather) are used to develop the fire support concept. Based on the appropriate battlefield situation scenarios (war-gaming each course of action to visualize how the battle would progress), the fire support concept is implemented by the Fire Support Annex.

FIRE SUPPORT ANNEX FORMAT

As indicated earlier, this prototype aid addresses only portions of the Fire Support Annex; those portions addressed are indicated with a ✓

✓ 1. SITUATION
- A. Enemy forces
- B. Friendly forces
- C. Attachments and Detachments

✓ 2. MISSION

3. EXECUTION
- ✓ A. Concept of Operation
- ✓ B. Air Support
  - (1) General
  - (2) Allocation
  - (3) Miscellaneous
- C. Chemical Support
  - (1) General
  - (2) Prescribed chemical load
  - (1) Miscellaneous
- ✓ D. Field Artillery Support
  - (1) General
  - (2) Organization for Combat
  - (3) Miscellaneous
- E. Naval Gunfire Support
  - (1) General
  - (2) Organization
  - (3) Miscellaneous
- F. Nuclear Fire Support
  - (1) General
  - (2) Prescribed nuclear load
  - (3) Miscellaneous
- ✓ G. Coordinating Instructions

4. SERVICE SUPPORT

5. COMMAND AND SIGNAL
- a. Command
- b. Signal

PHYSICAL ENVIRONMENT

What are the characteristics of the terrain?

- Observation and fire
- Cover and concealment
- Obstacles
- Key terrain features
- Avenues of approach

How will terrain affect enemy courses of action?

How will terrain affect own courses of action?

What is the projected impact of weather on enemy/own courses of action?

ENEMY FORCES

What enemy forces oppose you?

Where are the enemy forces?

What is the enemy's probable course of action? _____

_____

What is the enemy's timetable?

Where are the enemy's reserves?

Does the enemy have a capability to employ alternate courses of action?

If so, what are they?

_____

_____

_____

FRIENDLY FORCES/ASSETS

What is higher headquarters' plan?

1. SITUATION

b. Friendly Forces.

(1) MIDAG _____

What are the fire support plans of higher and adjacent headquaters?

(2) 2d Corps _____

(3) 4d Corps _____

(4) 3d ATAF _____

What fire support resources are attached/detached? What are their effective dates/times?

c. Attachments and Detachments. 315th Artillery Brigade attached effective D+5

What fire support assets are available?

ASSETS	WHEN
1st BN (LANCE)	NOW
2nd BN (LANCE)	NOW
311th Brigade (SP)	NOW
312th Brigade (SP)	NOW
313th Brigade (SP)	NOW
314th Brigade (I)	NOW
315th Brigade (SP)	D+5
CAS (A-10) 144 SORTIES	DAILY

MISSION/CONCEPT OF OPERATION

What is the corps' mission?

What is the required fire support task (i.e., mission)?

2. MISSION _____

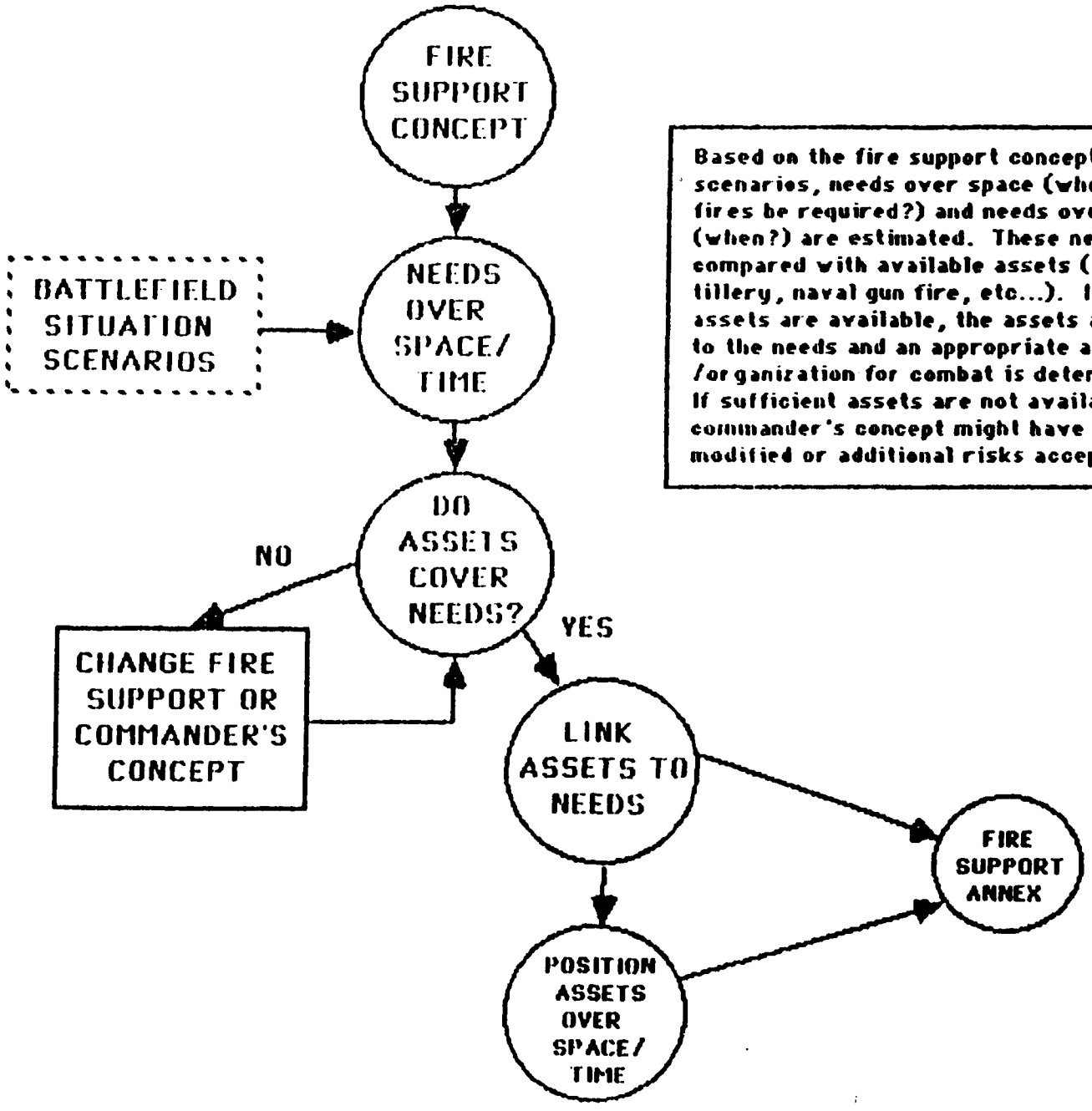
What is the commander's concept of operation?

What fire support operations are to be carried out to support the commander's concept?

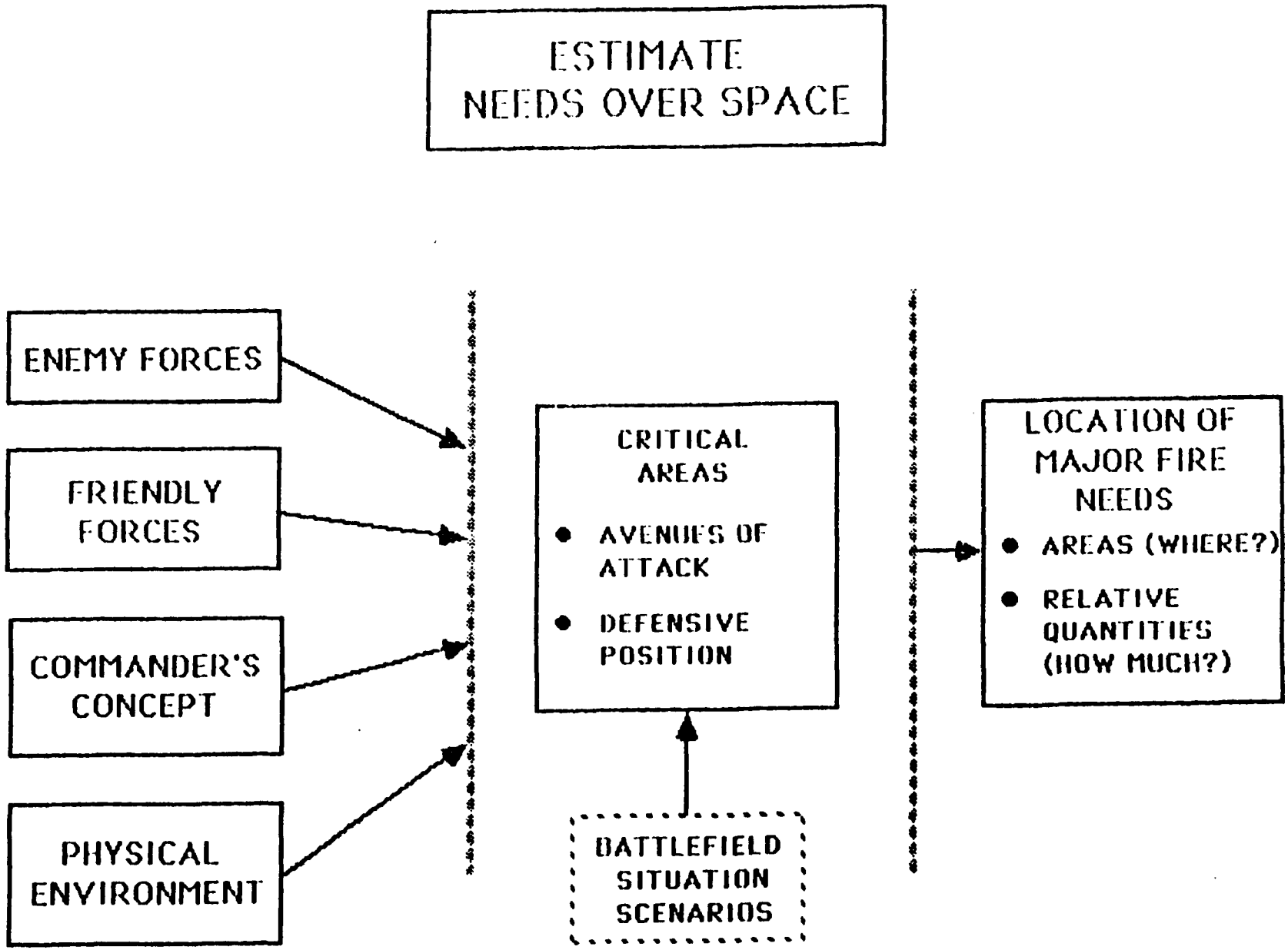
3. EXECUTION

a. Concept of Operation. _____

CAUSAL SCHEMA FIRE SUPPORT PLANNING PROCESS



Based on the fire support concept and the scenarios, needs over space (where would fires be required?) and needs over time (when?) are estimated. These needs are compared with available assets (air, artillery, naval gun fire, etc...). If sufficient assets are available, the assets are linked to the needs and an appropriate allocation /organization for combat is determined. If sufficient assets are not available, the commander's concept might have to be modified or additional risks accepted.


ESTIMATE
NEEDS OVER SPACE
ENEMY FORCES
FRIENDLY FORCES
COMMANDER'S CONCEPT
PHYSICAL ENVIRONMENT
CRITICAL AREAS
• AVENUES OF ATTACK
• DEFENSIVE POSITION
BATTLEFIELD SITUATION SCENARIOS
LOCATION OF MAJOR FIRE NEEDS
• AREAS (WHERE?)
• RELATIVE QUANTITIES (HOW MUCH?)

NEEDS OVER SPACE

Bearing in mind:

The commander's concept of operation;
enemy forces doctrine, disposition, and probable/alternative courses of action;
friendly forces; and
physical environment.

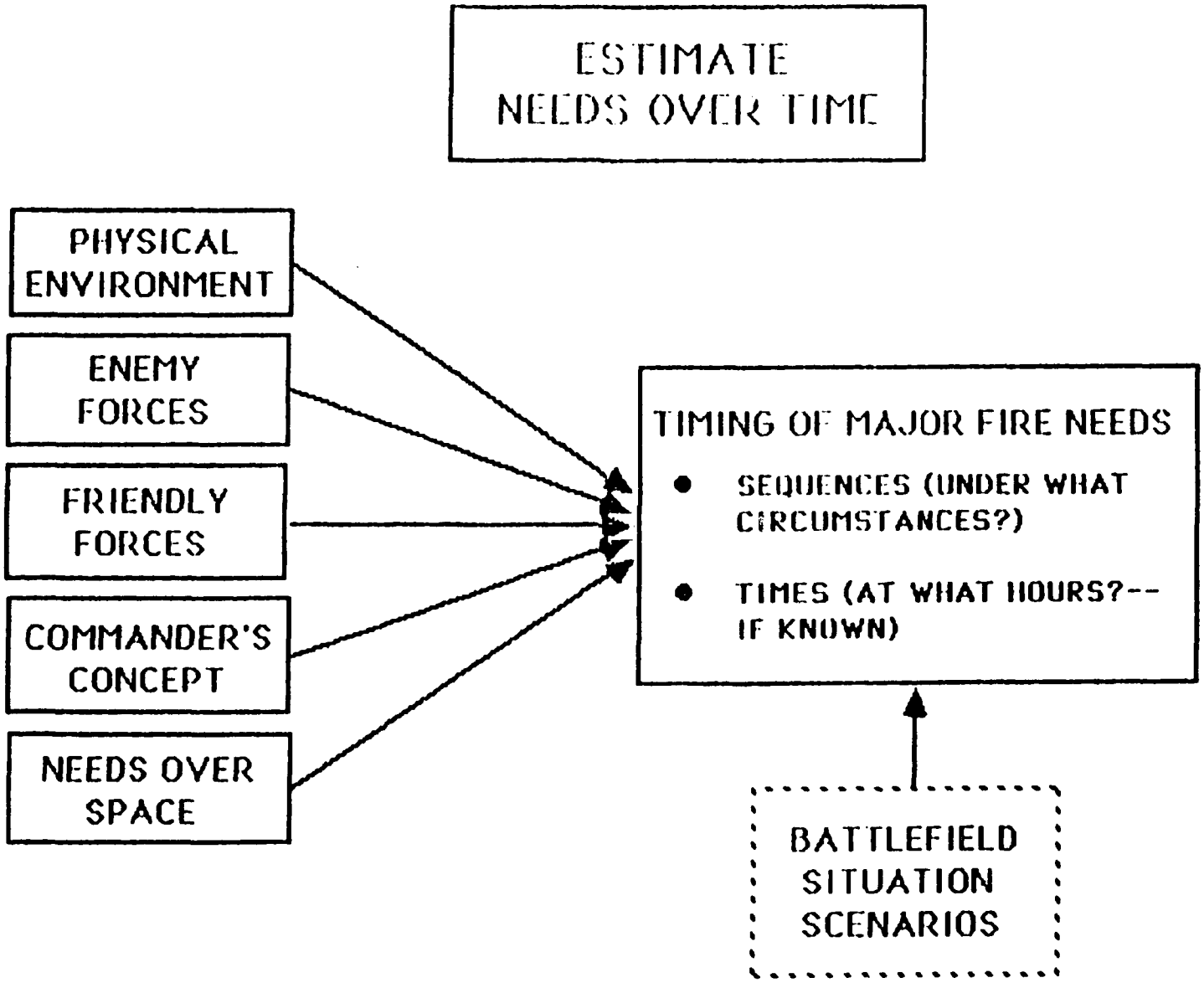
Considering the enemy's probable course of action identified previously in ENEMY FORCES, what fires would most likely be required to support the following? [Identify locations (fire zones) on the sketch map provided and indicate (by letter code) the action (s) the fires support].

The covering force (C)
The main battle
- Probable main attack (A)
- Probable secondary attack (S)
- Possible penetrations (P)
- Possible breakthroughs (B)
- Commitment of reserves (R)
- Withdrawal to new positions (W)
- Transition to the offense (T)

The deep attack (D)
Rear area combat operations (R)

How much fire would most likely be required in each location identified above? (Indicate, in each of the fire zones, relative quantity with a number between 1 and 10)

Bearing in mind that the enemy has the capability to employ alternate courses of action, what additional fires [indicate location, action (s) supported, and relative quantities on the sketch map provided] would most likely be required to support the alternative courses of action identified previously in ENEMY FORCES?


ESTIMATE
NEEDS OVER TIME
PHYSICAL ENVIRONMENT
ENEMY FORCES
FRIENDLY FORCES
COMMANDER'S CONCEPT
NEEDS OVER SPACE
TIMING OF MAJOR FIRE NEEDS
• SEQUENCES (UNDER WHAT CIRCUMSTANCES?)
• TIMES (AT WHAT HOURS?-- IF KNOWN)
BATTLEFIELD SITUATION SCENARIOS

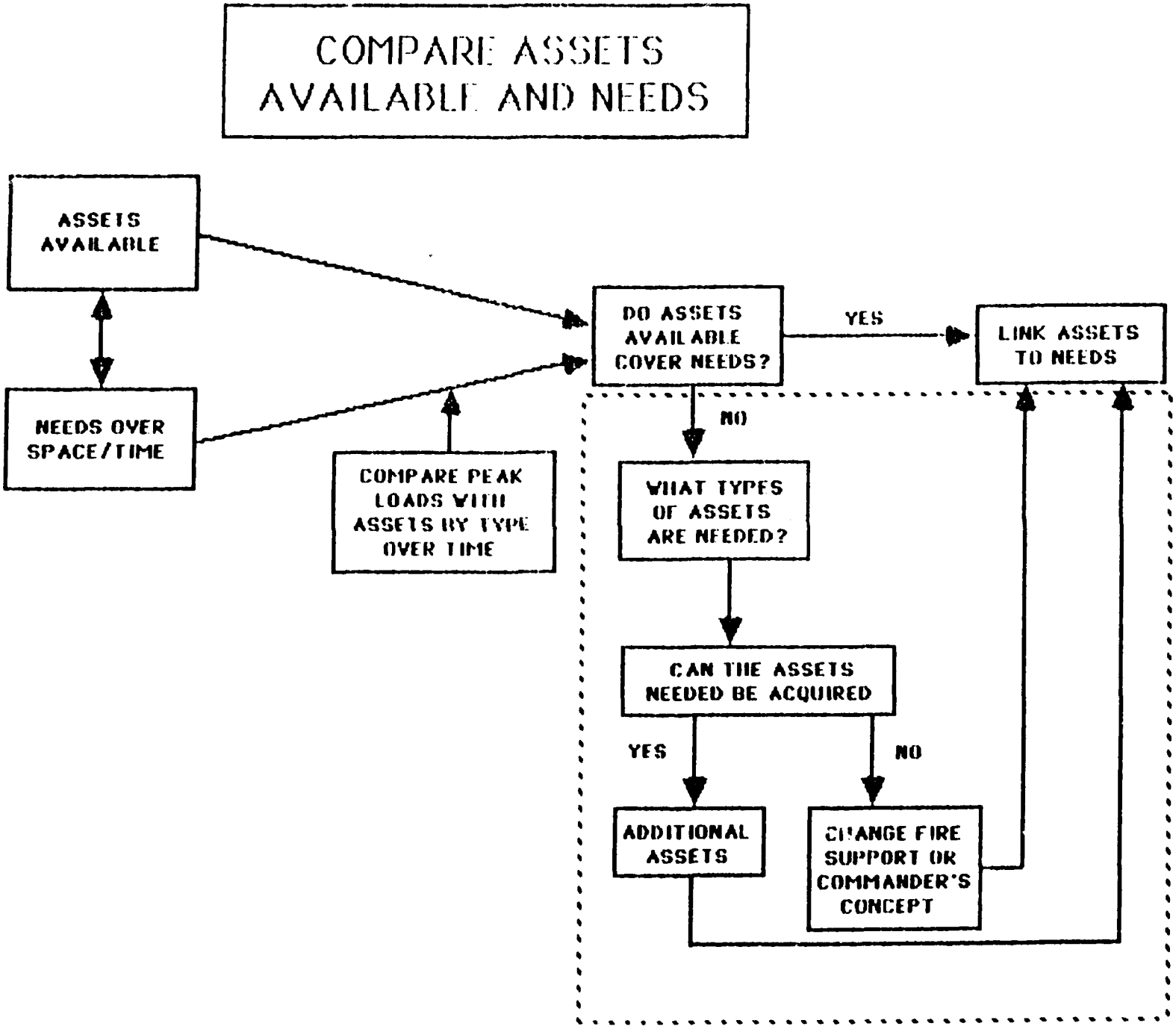
NEEDS OVER TIME

Bearing in mind:

The commander's concept of operation;
enemy forces doctrine, disposition, and probable/alternative courses of action;
friendly forces;
physical environment; and
NEEDS OVER SPACE

In what sequence (indicate by Roman Numerals in the fire zones) would each of fires most likely be required?

At what time (indicate D+/H+/day-night in the fire zones) would each of the fires most likely be required?


COMPARE ASSETS AVAILABLE AND NEEDS
ASSETS AVAILABLE
NEEDS OVER SPACE/TIME
COMPARE PEAK LOADS WITH ASSETS BY TYPE OVER TIME
DO ASSETS AVAILABLE COVER NEEDS?
YES
LINK ASSETS TO NEEDS
NO
WHAT TYPES OF ASSETS ARE NEEDED?
CAN THE ASSETS NEEDED BE ACQUIRED
YES
NO
ADDITIONAL ASSETS
CHANGE FIRE SUPPORT OR COMMANDER'S CONCEPT

ASSETS AVAILABLE/NEEDS

Bearing in mild:

The commander's concept of operation;
NEEDS OVER SPACE;
NEEDS OVER TIME; and
characteristics/capabilities of fire support assets

What fire support assets are required?

ASSETS	NO. REQUIRED	WHEN

What fire support assets are availible (from FRIENDLY FORCES/ASSETS)

ASSETS	WHEN
1st BN (LANCE)	NOW
2nd BN (LANCE)	NOW
311th Brigade (SP)	NOW
312th Brigade (SP)	NOW
313th Brigade (SP)	NOW
314th Brigade (T)	NOW
315th Brigade (SP)	D+5
CAS (A-10) 144 SORTIES	DAILY

Do available assets cover required assets?

If yes, proceed to assign assets to needs.
If no, what additional assets are required?

ASSETS	NO. REQUIRED	WHEN

Can additional assets be obtained?

ASSETS AVAILABLE/NEEDS (CONTINUED)

If additional assets can be obtained, proceed to LINK ASSETS TO NEEDS.

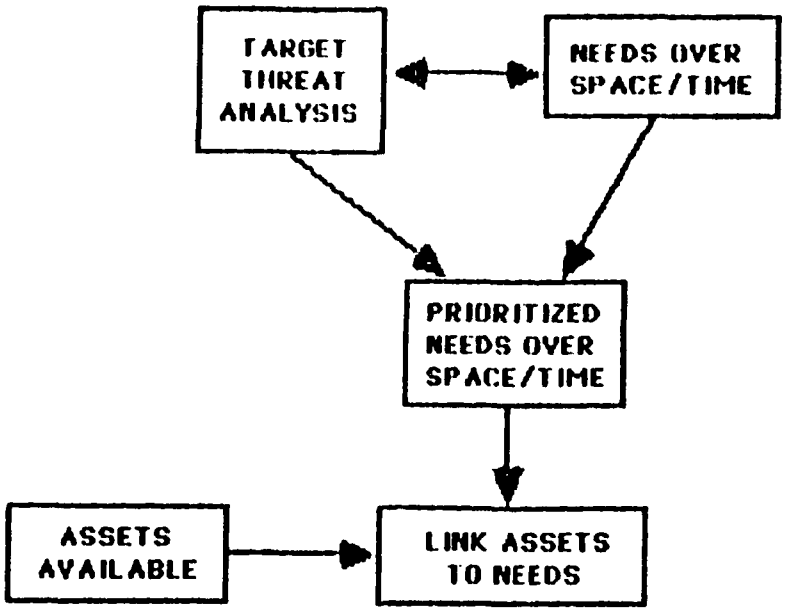
If additional assets cannot be obtained, recognize that some of the needs will not be met within the time originally identified as required and reexamine required assets.

Can the commander's concept be supported with a modified fire support concept?

If yes, proceed to reexamine NEEDS OVER SPACE/TIME

If no, alert G3 to the additional risks as a result of the short fall.

LINK ASSETS TO NEEDS



ASSIGN ASSETS TO NEEDS

Bearing in mind:
- The commander's concept of operation;
- enemy forces;
- friendly forces;
- physical environment;
- NEEDS OVER SPACE; and
- NEEDS OVER TIME

Which of the needs identified previously in NEEDS OVER SPACE/TIME as most likely to be required to support the covering force, address enemy forces/targets which could:
- Prevent the execution of the plan? (PRIORITY 1 FIRES)
- Seriously interfere with the plan? (PRIORITY 2 FIRES)
- Cause serious interference at a later time? (PRIORITY 3 FIRES)
- Cause limited interference with the plan? (PRIORITY 4 FIRES)

Indicate, in each of the fire zones, the priority assigned (P1 - P4).

Bearing in mind the priorities of fires and the characteristics/capabilities of available assets, which asset (or set of assets) is most likely to be required to support each covering force need (or set of needs)? Indicate this assignment on the sketch map.

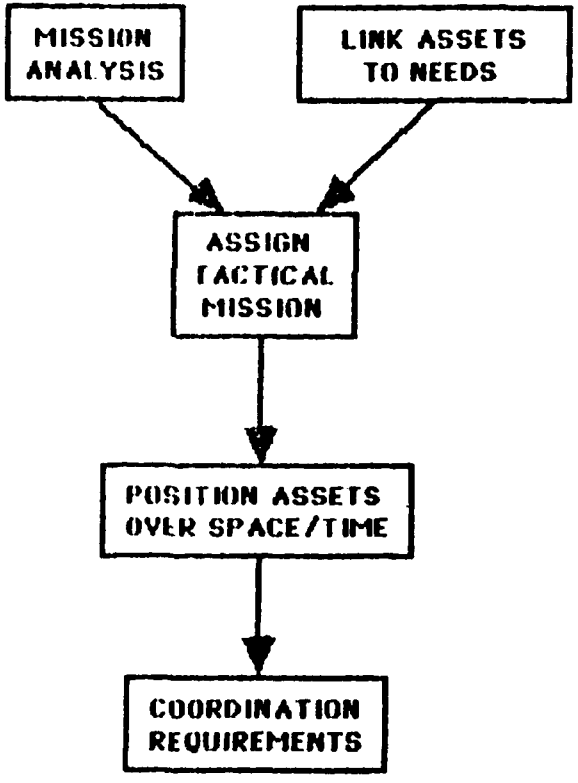
Repeat the above process for the needs identified as most likely to be required to support the main battle.

Repeat the above process for the needs identified as most likely to be required to support the deep battle.

Repeat the above process for the needs identified as most likely to be required to support rear area combat operations.

Considering all four elements (i.e., covering force, main battle, deep battle, and rear area combat operations), are there any linkage (of assets to needs) assignments previously made which should be modified?

POSITION ASSETS OVER SPACE/TIME



POSITION ASSETS OVER SPACE/TIME (CONTINUED)

FIELD ARTILLERY SUPPORT

What is the general concept of field artillery support, to include phasing, duration, or general employment?

d. Field Artillery Support

(1) General. _____

_____

_____

What organization for combat is appropriate to support the covering force?

1st Bn _____
2nd Bn _____
311 Bde _____
312 Bde _____
313 Bde _____
314 Bde _____
315 Bde _____

What changes/additions to the above organization for combat are necessary to support the main battle, the deep battle, and rear area combat operations?

(2) Organization for combat

1st Bn _____
2nd Bn _____
311 Bde _____
312 Bde _____
313 Bde _____
314 Bde _____
315 Bde _____

POSITION ASSETS OVER SPACE/TIME

Bearing in mind:
The commander's concept of operation;
enemy forces;
friendly forces;
physical environment; and
LINKING OF ASSETS TO NEEDS

AIR SUPPORT

What are the major roles/tasks to be carried out by air elements in support of the operation?

3. EXECUTION

a. Air Support

(1) General. _____

_____

How are the available 144 (A-10) daily sorties to be allocated?

(2) Allocation

4th Armored Div	_____
80th Mech Div	_____
90th Mech div	_____
_____	_____
_____	_____
_____	_____
Corps	_____

Are there any points of detail not covered above?

(3) Miscellaneous. _____

_____

POSITION ASSETS OVER SPACE/TIME (CONTINUED)

Are there any points of detail not covered above?

(3) Miscellaneous. _____

_____

Where should those units retained under corps control be located to support the covering force? Where should they be located to support the main battle, the deep battle, and rear area combat operations?

What coordinating measures are appropriate to facilitate the rapid engagement of targets in the covering force area, and at the same time, provide appropriate safeguards for friendly forces? Are additional coordinating measures appropriate to the main battle, the deep battle, and/or rear area combat operations?

g. Coordinating Instructions. _____

_____

_____

REVIEW FIRE SUPPORT ANNEX

Does the Fire Support Annex support the corps' mission and the commander's concept of operation with acceptable risks?

Does the Fire Support Annex address:

Our knowledge of the physical environment (weather and terrain), enemy forces, and friendly forces?

Our understanding of the enemy's probable and alternate courses of action?

Our responses to the enemy's probable and alternate courses of action and their likely consequences?

Does the Fire Support Annex provide for:

Centralize control of assets?

Use of mobility to concentrate indirect fires?

Engagement of the enemy as far forward as possible?

Is the Fire Support Annex clear, concise, and unambiguous?